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ORIGINAL ARTICLES

Correlation of laparoscopic and hysteroscopic 30° scope camera navigation skills on box trainers

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Abstract This study investigated a possible correlation between training of camera navigation skills with a 30° optic in hysteroscopy and laparoscopy by exploring whether 30° camera navigation training in hysteroscopy provides a certain level of expertise in laparoscopic camera navigation. If a correlation exists, training models and programs in gynecology could be simplified. In this prospective, randomized, nonblinded study 34 medical students were divided into two groups. Group A (n=17) performed five exercises on a box trainer for hysteroscopy (HYSTT) and five exercises on a box trainer for laparoscopy (LASTT). Group B (n=17) performed 2×5 exercises on the LASTT model. Both groups performed a LASTT post-test directly afterwards. The outcome parameter recorded was time to correctly perform the exercise. Comparing the results of the LASTT post-test between group A and B, a similar performance of both groups was shown (p=.131). A slightly faster performance in group A is displayed, when comparing the first LASTT exercise between group A (with previous HYSTT training) and group B (without previous HYSTT training); however, this was a nonsignificant finding (p=.114). Both groups display quite similar learning curves, and after five LASTT repetitions, both groups have reached comparable levels for procedure time, despite the earlier HYSTT training of group A. Previous training on the HYSTT model offers some advantage for training on the LASTT model. However, training of 30° camera navigation skills in a hysteroscopic environment does not seem supportive for obtaining the same level of camera expertise in laparoscopy. Therefore, 30° camera navigation in hysteroscopy and laparoscopy should be trained separately to reach adequate levels of expertise for each procedure.

Keywords Box trainer · Hysteroscopy · Laparoscopy · Training · Camera navigation · Angled optic

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Background

Laparoscopy and hysteroscopy have become standard procedures in gynecology. During endoscopic procedures, good visualization of the surgical field is essential and this is achieved by adequate camera navigation [1–3]. Camera navigation is often perceived to be an easy task, but it is far from an innate ability. Psychomotor skills need to be learned to overcome the barriers that are known for endoscopic skills in general, namely the fulcrum effect, loss of binocular vision, a fixed access point, and decreased range of motion [3, 4]. In addition, skills unique to camera navigation include maintaining a correct horizontal axis while centering the operative field, focusing and sizing, maintaining a steady image, and tracking instruments in motion [2, 3]. Especially, angled scopes, by the addition of off-axis viewing, require complex visuospatial skills [5].

In laparoscopy, handling of the camera is often performed by the least experienced person present. Incorrect camera handling results in poor visualization and may cause frustration of the operator, increased operating time and errors [1, 3, 5]. In hysteroscopy, camera navigation is essential due to the decreased range of motion when navigating through the narrow cervical canal and uterine cavity. A 30° angled scope affords an increased view with fewer movements and is increasingly used for vaginoscopic hysteroscopy in the office setting. But when knowledge and skills are lacking, the 30° angled scope can lead to unnecessary damage of the cervical canal and endometrium. In a national UK survey among gynecologists, a disappointing percentage of 25.8 of all responders who perform 30º hysteroscopy showed understanding of the principles of 30º angled view [6].

Despite the importance of camera navigation skills, they are not often explicitly addressed in training programs [7, 8]. However, camera navigation skills can be trained easily and effectively outside the operating room [5, 9–11]. During the past years, several models have been developed and validated for camera navigation training in laparoscopy [3, 12, 13] and to a lesser extent in hysteroscopy [14]. The same principles can be observed in urology as well, for laparoscopy and cystoscopy [15]. Even though endoscopy comprises different types of procedures (e.g., laparoscopy and hysteroscopy), they all require mastering of adequate camera navigation skills with a 30° optic. One could question whether a possible correlation exists between the training of camera navigation skills with a 30° optic in hysteroscopy and laparoscopy even though the environments of the abdominal and uterine cavity are fairly different. If this correlation exists, it implies that obtaining 30° camera navigation skills in hysteroscopy also indicates the built up of a certain level of expertise in laparoscopy camera handling. This would mean that training models and programs in gynecology could be simplified. Furthermore, it might also apply for other specialties, for example cystoscopy and laparoscopy in urology. That could lead to a situation in which several endoscopic specialties could train 30° camera navigation on a uniform training model, without a direct relation between the model, a specific organ, cavity or specialty, and the type of endoscopy.

The aim of the present study is to investigate whether 30° camera navigation practice in hysteroscopy also creates a built up of expertise in laparoscopic 30° camera navigation.

Two box trainers have been used in this study: the laparoscopic skills testing and training (LASTT) model and the hysteroscopic skills testing and training (HYSTT) model. Both were designed under auspices of the European Academy for Gynaecological Surgery (Leuven, Belgium). These models train various psychomotor skills including specific exercises for 30° camera navigation training [12, 14].

Methods

Participants and setting

From April to June 2013, 34 novices voluntarily participated in this study. Medical students served as novices and they were invited during or after their gynecology internship via oral and written means, and all agreed to participate. The study was carried out at the University Medical Center Utrecht and at the teaching hospital St. Antonius Ziekenhuis, Nieuwegein, the Netherlands. All participating students filled out a questionnaire which recorded their baseline characteristics. The study was exempt from the institutional review board approval, since no potential harm could be done to humans or nonhumans. All participants gave written consent prior to the start of the study.

Design

This study is a prospective, randomized, nonblinded trial. The participants were divided into two groups by randomization by sealed envelopes. Short series of exercises were designed for the present study, because Molinas et al. observed a plateau phase for the LASTT 30° camera navigation exercise after 5–15 repetitions [12]. Figure 1 displays the scheme of exercises per group. In addition, the scheme shows the two comparative analyses. Analysis 1 addresses the question whether mixed training will lead to the same laparoscopy level as only-laparoscopy training, by comparing the LASTT post-test between both groups. Analysis 2 addresses the question whether prior hysteroscopy training will lead to a higher achievement in laparoscopy in comparison to a short laparoscopy training only. This analysis will compare the first LASTT exercise of group A (with previous HYSTT training) with the first LASTT exercise of group B (without previous HYSTT training).

Both groups received a short standardized introduction on 30° optics and the study protocol. Group A (n=17) was given a specific introduction on hysteroscopy and the HYSTT model, while group B (n=17) received a similar standardized introduction on laparoscopy and the LASTT model. One-minute practice time was given to each participant to obtain familiarization with the model; during this practice time, feedback and instructions were provided. Then, group A performed the HYSTT exercise five times, followed by a 5-min break. During the break, group A received the standardized introduction on laparoscopy and the LASTT model, and 1-minute practice time was provided. After the break, group A performed the LASTT exercise five times, followed by a final LASTT repetition which was recorded as a post-test. Group B performed the LASTT exercise five times, also followed by a 5-min break. After the break, this group repeated the LASTT exercise another five times and performed the post-test on the LASTT model. The post-test, as performed by both groups, consists of a single repetition of the camera navigation exercise on the LASTT model and is performed directly after the training sessions in the same environment. One investigator (E.H.) supervised all exercises and tests to limit intersupervisor bias. During all exercises and tests, no feedback or instructions were provided nor could any questions be asked. After each repetition, the participant could ask questions and feedback was offered.

Materials

The LASTT model consists of a wooden platform (16.5×30 cm) with two modules in the back, two modules in

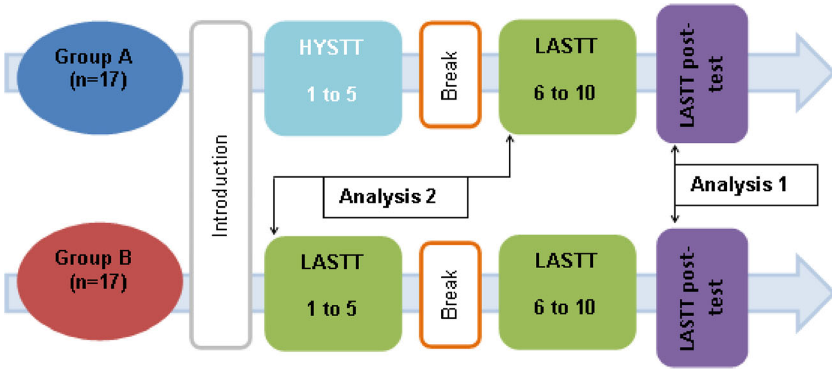

Fig. 1 Study design: scheme of exercises per group. Analysis 1 addresses the question whether mixed training will lead to the same laparoscopy level as only-laparoscopy training under the condition of equal time investment, by comparing the LASTT post-test between both groups. Analysis 2 addresses the question whether prior hysteroscopy training will lead to a higher achievement in laparoscopy in comparison to a short laparoscopy training only, by comparing the first LASTT exercise of group A (with previous HYSTT training) with the first LASTT exercise of group B (without previous HYSTT training)

the middle, and two modules in the front. These modules contain in total of 14 targets. Each target consists of a large symbol, only identifiable from a panoramic view, and a small symbol, only identifiable from a close-up view [12]. The LASTT model was inserted into a Szabo trainer box (Karl Storz, Tutlingen, Germany) (Fig. 2a).

The HYSTT model consists of a white plastic uterus model in which twelve symbols are placed at twelve locations, known as front/mid/back (referring to the depth of the space) combined with anterior/posterior/left/right (referring to the walls of the space). Six models are available in which each location contains a different symbol (models A–F). This plastic uterus is placed in a silicone model of a vulva, which in turn is situated in a plastic pelvis model (Fig. 2b). Originally, the HYSTT model contained 14 target locations with anatomical names as “fundal anterior”, “cornual left”, “tubal ostium right”, and “isthmic posterior”. Due to the observation in a pilot study that these anatomical names seem confusing when applied in this simple uterus, the model was adjusted by covering the “cornual” symbols and by renaming the other twelve locations by general terms as front/mid/back.

Both models were designed under auspices of the European Academy for Gynaecological Surgery (Leuven, Belgium). The exercises on the LASTT model were performed with a 10 mm 30° scope and the exercises on the HYSTT model with a 5 mm 30° scope (Karl Storz), both connected to the same straight video camera, light source, and monitor (Telepack, Karl Storz). With regards to the exercises, a black circle (2.5 cm in diameter) was applied in the center of the monitor. The box trainers and the monitor were set up on a large table in line with each other.

Exercises

The participants stood behind the box trainer in the midline, holding the camera with their dominant hand and the fiber optic cable with their nondominant hand for lateral, rotatory, and zoom-in/out navigation. For the LASTT exercise, the scope was inserted through the middle port of the trainer box. At the start of the exercise, the participant had to visualize the first large symbol (i.e., 1) and then identify the small one situated next to it. The small symbol had to be sharply visualized inside the black circle on the screen. This small symbol indicated the next large symbol that had to be visualized. The exercise was finished when the small symbol on the last target (end) was identified correctly. After every run, the targets were ordered differently according to a standardized schedule to prevent memorization.

For the HYSTT exercise, the scope was inserted into the uterus model (model B) through the silicone vulva. The participant had to navigate to a specific location (e.g., mid posterior) as commanded by the investigator and visualize the corresponding symbol inside the black circle on the monitor, after which a new command was given until all 12 symbols were correctly visualized. After every completed session, the sequence of the commands was changed according to a standardized schedule, and after three sessions, another uterus model (model C) was inserted for the last two sessions to prevent memorization.

Outcome measure

The outcome measure for both the HYSTT and LASTT exercises was the total time (recorded in seconds) needed to correctly visualize all the signs.

Statistical analysis

The statistical analysis was performed with SPSS 20.0 for Windows. A power analysis was performed prior to the study to determine the minimal sample size. It showed that a power level of 0.8 with a desired significance level of 0.05 and a difference of 1 SD between groups should be reached at a minimal total sample size of 34 participants. To compare the

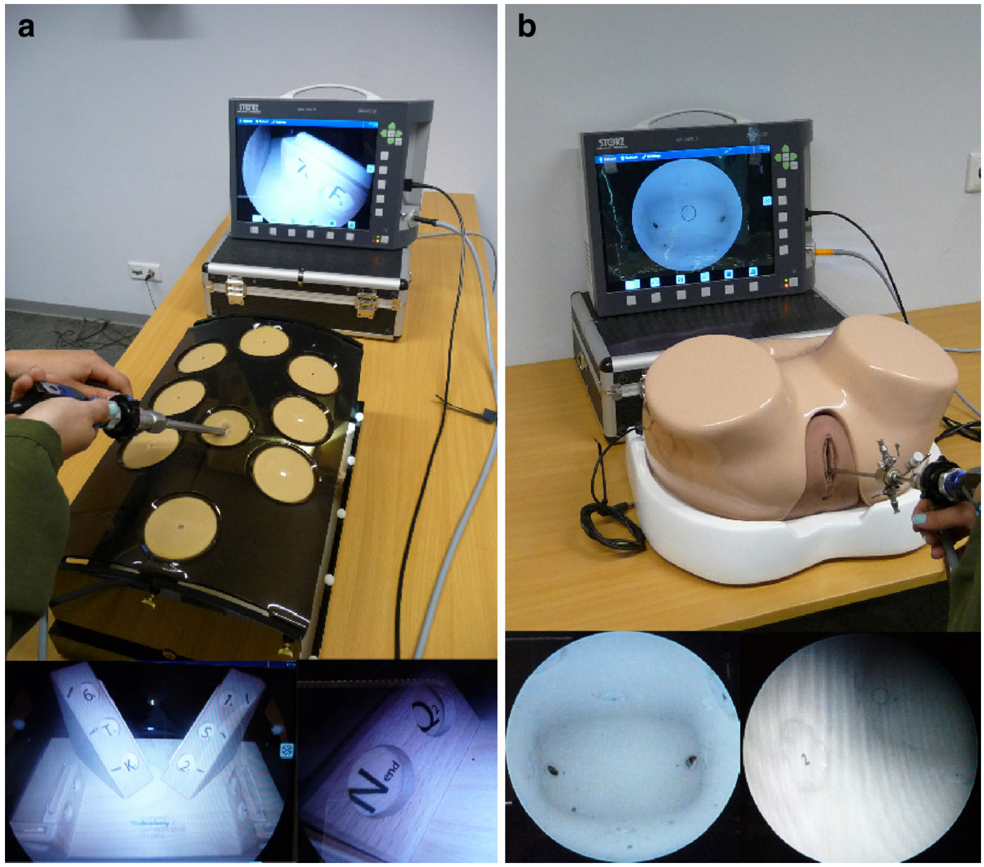

Fig. 2 **a** Set up LASTT model. **b** Set up HYSTT model

participants' characteristics, the chi-square test was used. Differences in the time measurements between the two groups were analyzed using the nonparametrical Mann–Whitney *U* test for independent samples. The results are presented as medians with interquartile ranges (IQR) and were considered significant in case of a *p* value<.05.

Findings

The baseline characteristics of the participants are reported in Table 1. The participants were randomized into two groups (n=17 per group), and there were no significant differences regarding personal characteristics between these groups. Both groups existed of five men (29.4 %) and 12 women (70.6 %). The median age in group A was 23 years (IQR 22–23) and in group B, 23 years (IQR 23–24). All participants had attended at least one hysteroscopy and/or laparoscopy.

When comparing the results of the LASTT post-test between groups A and B (analysis 1), a similar performance of both groups is shown. The median time needed to complete the post-test was 100.3 (IQR 88.1–121.8)s for group A and 91.1 (IQR 77.2–104.4)s for group B (p=.131) (Fig. 3).

Figure 4 displays the median time of both groups per LASTT exercise graphically. It shows that both groups have reached approximately the same level of procedure time during their post-test, and this endorses the results of a similar performance described above. However, despite of their earlier training on the HYSTT model, group A follows more or less the same (steep) learning curve as group B in the first LASTT series instead of following the (flatter) curve in the second LASTT series of group B.

Analysis 2 compares the first LASTT exercise between group A (with previous HYSTT training) and group B (without previous HYSTT training). Group A performed the exercise slightly faster than group B, but this was a nonsignificant finding (p=.114). The median performance time of group A was 214.3 (IQR 152.2–261.6)s, while group B recorded a median time of 249.6 (IQR 178.9–307.0)s (Fig. 3).

Both groups display quite similar learning curves, and after five LASTT repetitions, both groups have reached comparable levels for procedure time, despite the earlier HYSTT training of group A.

Discussion

Training programs for endoscopic skills vary throughout institutions worldwide. Furthermore, every specialty has its own training models for specific procedures. As described in the

Table 1 Demographic characteristics of the participants

Characteristics		Group A (*n*=17)	Group B (*n*=17)
Age (years), mean (range)		22.71 (21–26)	23.47 (22–25)
Sex	Male	5	5
	Female	12	12
Dominant hand	Right	13	15
	Left	4	2
Desired future specialty	Surgical	8	10
	Nonsurgical/do not know	9	7
No. of attended hysteroscopy/laparoscopy	1–10	11	8
	>10	6	9

Participants were randomized by sealed envelopes. No statistically significant differences were found between both groups (statistical analysis performed with chi-square test)

introduction, the basic skills required for different endoscopic procedures are fairly similar and endoscopy training outside the operating room could be standardized [7, 12]. This led to the idea that certain general endoscopic skills, such as 30° camera navigation, might be trained on a uniform training model. This study investigated whether a correlation exists between training of camera navigation skills with a 30° optic in hysteroscopy and laparoscopy by exploring whether 30° camera navigation training in hysteroscopy provides a certain expertise in laparoscopic camera navigation.

Firstly, the results show that regardless of training on the HYSTT or the LASTT model, 30° optic skills are easily learned when a standardized explanation and specific exercises for camera navigation are provided. Medical students were able to strongly improve their performance within five repetitions on the LASTT model, reaching a time score of 110 s. This was faster than expected by the results of Molinas et al., where novices (students and inexperienced gynecologists) needed approximately 10 repetitions to reach a procedure time of 110 s [12]. However, in both studies, certain variability between subjects is observed. In the current study, it is not investigated whether this fast performance is lasting.

Secondly, concerning a possible correlation for camera navigation, a similar performance of both groups during the LASTT post-test was found (analysis 1). This might indicate that previous hysteroscopy training does provide built up of expertise in laparoscopic camera navigation. However, after apprehending the fast learning curve in this study, a similar performance after five repetitions can be expected regardless of previous training. And even though group A (with previous HYSTT training) did perform slightly better than group B (without previous HYSTT training) during their first LASTT exercise, this finding was not significant (analysis 2). In addition, the learning curves of both groups were fairly similar when they started performing exercises on the LASTT. Therefore, according to these results, the existence of a pronounced correlation between training of 30° camera navigation skills in hysteroscopy and laparoscopy seems implausible.

A possible explanation for not finding a correlation could be that even though the principles of angled optics are easy to learn when time, attention, and exercises are provided, the abdominal and uterine cavity are too different regarding space and shape. In the uterus and in the corresponding HYSTT model, camera navigation takes place within a small and

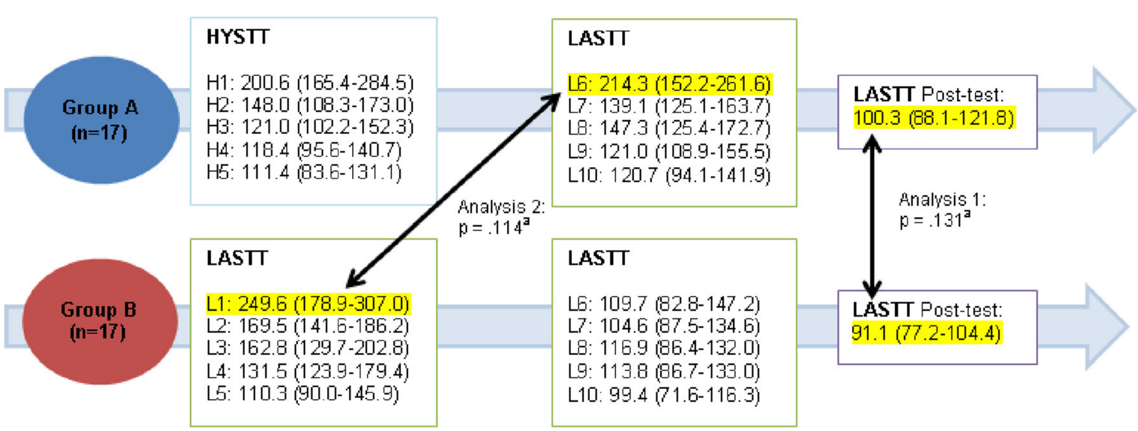

Fig. 3 Median results with interquartile ranges (IQR) in seconds per exercise per group, for both HYSTT and LASTT exercises. Analysis 1 compares the outcome of the LASTT post-test of both groups. Analysis 2 compares the first LASTT exercise of group A (with previous HYSTT training) with the first LASTT exercise of group B (without previous HYSTT training). Statistical analysis performed with Mann–Whitney *U* test

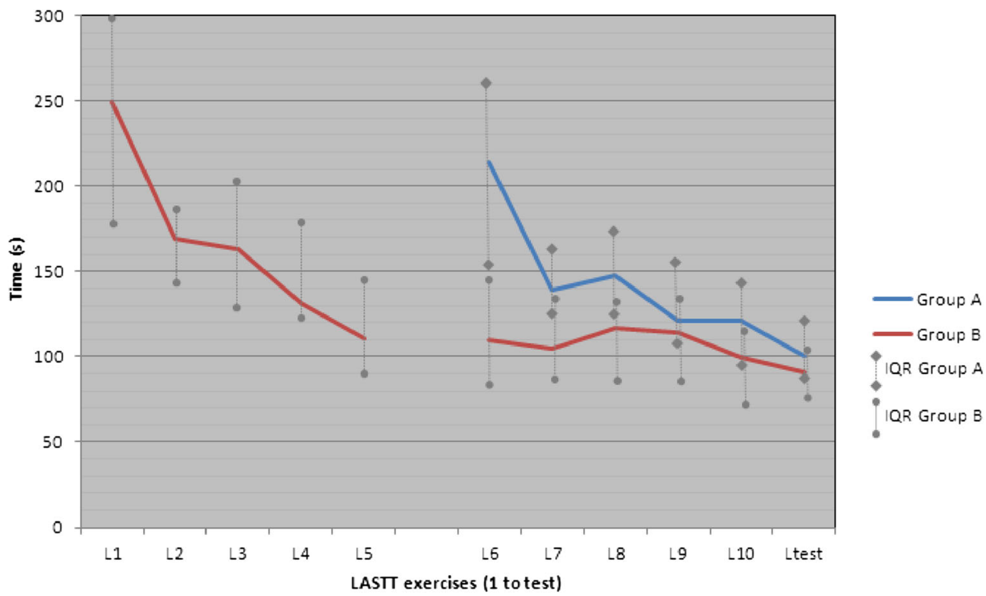

Fig. 4 Median time in seconds of the LASTT repetitions of group A (*blue line*) and group B (*red line*). Interquartile ranges (IQR) are represented by the *vertical gray lines*. Both groups have reached approximately the same level of procedure time at the end of their LASTT exercises. Group A more or less followed the same learning curve as group B in the first LASTT series

narrow cavity (a specific organ), which requires subtle movements of the scope combined with extensive angled optic use. In the abdomen and in the corresponding LASTT model, a distinctly higher degree of freedom of scope movement is observed. This is due to the wide space after CO^2 inflation during laparoscopy and the environment within the spacious box trainer, respectively. One has to train how to navigate and to apply the principles of angled optics in each different cavity. Camera navigation in hysteroscopy and laparoscopy should be trained separately to reach adequate levels of expertise for each procedure.

Strong points of the present study are the power analysis performed prior to the study and the randomization process, which was executed effectively. The study was nonblinded, because blinding was not possible due to the distinctly different appearances of the two box trainers. Medical students were included in this study as novices, because of their blank training background which gave all participants the same starting point.

The current study design was not established as a proficiency-based training curriculum, since the aim was to investigate a correlation between skills acquisition in two training environments and not to evaluate the efficacy of a curriculum. The number of repetitions was kept small to ensure that participants were not yet fully proficient at the HYSTT model before training at the LASTT box. We wanted to see if the change of environment would alter the ongoing learning curve in comparison to the group that continuously trained at the LASTT model. One could argue that a proficiency-based study design with a 'retention test' performed several weeks to months after the training might provide a better way to investigate our hypothesis, and this presents an area for future research. For clinical use, it should be emphasized that the design of an efficient training curriculum needs to be proficiency-focused to accommodate the ability and development of each individual [16].

One of the factors that might have influenced the current results is the fact that the exercises per model differ in the way they have to be executed. During the HYSTT exercise, the participants had to follow the investigator's commands, whereas in the LASTT exercise, the visualized sign itself included the next command. Furthermore, time to correctly perform the exercise is the only outcome parameter recorded, and it is recorded by a person. One can imagine that a computerized system as in a virtual reality simulator can offer a more objective scoring and that other factors might affect performance; after all, a faster performance does not automatically mean a better performance. Outcome parameters as the number of errors, path length, camera stability, and number of collisions were not recorded, which is inherent to the design of box trainers. In addition, box trainers in general often lack a realistic display of human anatomy. Even though, box trainers have proven to be simple and relatively cheap models that can effectively train specific psychomotor skills needed for endoscopy [4, 12, 17]. On the other hand, the possibly influencing factors of a box trainer might be overcome by using virtual reality simulators, which objectively record various parameters. The software could provide similar commands for both exercises and record parameters that could display the varying nuances in camera navigation that one has to train when performing both hysteroscopy and laparoscopy. This might provide an area for future research. In addition, it could be an interesting idea for future research to include a test on visuospatial abilities for all participants, in order to retrieve extra information on the training capacity for endoscopic skills.

Conclusion

Correct camera navigation skills with a 30° optic are essential in endoscopy and need to be trained outside of the operating room. This study shows that, regardless of training on the HYSTT or the LASTT model, 30° optic skills are easily learned when specific exercises for camera navigation are provided. Previous training on the HYSTT model offers some advantage for training on the LASTT model, compared to no previous training. However, training of camera navigation skills in a hysteroscopic environment does not seem supportive for obtaining the same level of camera expertise in laparoscopy. The two environments appear too distinct to train both procedures on one unified model. Therefore, 30° camera navigation in hysteroscopy and laparoscopy should be trained separately to reach adequate levels of expertise for each procedure.

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Conflict of interest For all authors, there is no financial interest. All the authors have nothing to disclose, and no funding was received for this study.

Ethics approval The study was exempt from the institutional review board approval, since no potential harm could be done to humans or nonhumans. All participants gave written consent prior to the start of the study.

References

1. Conrad J, Shah AH, Divino CM, Schluender S, Gurland B, Shlasko E, Szold A (2006) The role of mental rotation and memory scanning on the performance of laparoscopic skills. Surg Endosc 20:504–510
2. Shetty S, Panait L, Baranoski J, Dudrick SJ, Bell RL, Roberts KE, Duffy AJ (2012) Construct and face validity of a virtual reality-based camera navigation curriculum. J Surg Res 177:191–195
3. Korndorffer JR, Hayes DJ, Dunne JB, Sierra R, Touchard CL, Markert RJ, Scott DJ (2005) Development and transferability of a cost-effective laparoscopic camera navigation simulator. Surg Endosc 19:161–167
4. Schreuder HWR, van den Berg CB, Hazebroek EJ, Verheijen RHM, Schijven MP (2011) Laparoscopic skills training using inexpensive box trainers: which exercises to choose when constructing a validated training course. BJOG 118(13):1576–1584
5. Ganai S, Donroe JA, St. Louis MR, Lewis GM, Seymour NE (2007) Virtual-reality training improves angled telescope skills in novice laparoscopists. Am J Surg 193:260–265
6. Tawfeek S, Scott P (2010) National inpatient diagnostic hysteroscopy survey. Gynecol Surg 7:53–59
7. VanBlaricom AL, Goff BA, Chinn M, Icasiano MM, Nielsen P, Mandel L (2005) A new curriculum for hysteroscopy training as demonstrated by an objective structured assessment of technical skills (OSATS). AJOG 193:1856–1865
8. Kingston A, Abbott J, Lenart M, Vancaillie T (2004) Hysteroscopic training: the butternut pumpkin model. J Am Assoc Gynecol Laparosc 11(2):256–261
9. Paschold M, Niebisch S, Kronfeld K, Herzer M, Lang H, Kneist W (2013) Cold-start capability in virtual-reality laparoscopic camera navigation: a base for tailored training in undergraduates. Surg Endosc 27:2169–2177
10. Franzeck FM, Rosenthal R, Muller MK, Nocito A, Wittich F, Maurus C, Dindo D, Clavien PA, Hahnloser D (2012) Prospective randomized controlled trial of simulator-based versus traditional in-surgery laparoscopic camera navigation training. Surg Endosc 26:235–241
11. Andreatta PB, Woodrum DT, Birkmeyer JD, Yellamanchilli RK, Doherty GM, Gauger PG, Minter RM (2006) Laparoscopic skills are improved with LapMentor™ training. Results of a randomized double-blinded study. Ann Surg 243:854–863
12. Molinas CR, De Win G, Ritter O, Keckstein J, Miserez M, Campo R (2008) Feasibility and construct validity of a novel laparoscopic skills testing and training model. Gynecol Surg 4(5):281–290
13. Yee KA, Karmali S, Sherman V (2009) Validation of a simple camera navigation trainer. J Am Coll Surg 209:753–757
14. Janse JA, Tolman CJ, Veersema S, Broekmans FJM, Schreuder HWR (2013) Hysteroscopy training and learning curve of 30º camera navigation on a new box trainer: the HYSTT. Gynecol Surg. doi:10.1007/s10397-014-0833-9
15. Schout BMA, Ananias HJK, Bemelmans BLH, d'Ancona FCH, Muijtjens AMM, Dolmans VEMG, Scherpbier AJJA, Hendrikx AJM (2009) Transfer of cysto-urethroscopy skills from a virtual-reality simulator to the operating room: a randomized controlled trial. BJUI 106:226–231
16. De Win G, Van Bruwaene S, Allen C, De Ridder D (2013) Design and implementation of a proficiency-based, structured endoscopy course for medical students applying for a surgical specialty. Adv Med Educ Pract 4:103–115
17. Chou B, Handa VL (2006) Simulators and virtual reality in surgical education. Obstet Gynecol Clin N Am 33:283–296